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ABSTRACT

This document evaluates the second phase of the Science Online Support Network (SOLSN) Project. The SOLSN Project supports primary teachers in professional development, improving standards of science teaching and learning, and improving continuity for students across the elementary and early secondary grades. This report evaluates the project, which took place between November, 1999 and April, 2000. (YDS)

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ED 446 959

Using ICT to Support Teachers in Primary Schools

An Evaluation of Phase Two of the Science Online Support Network

Lydia Plowman
Alison Leakey
Wynne Harlen

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SCRE 2

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Lydia Plowman
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The Scottish Council for Research in Education

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Executive Summary

Introduction

1 The Science Online Support Network (SOLSN) is managed by SSERC (Scottish Schools Equipment Research Centre) and is currently provided in the form of a CD-ROM with website links to science resources. It is intended to support teachers in primary schools who are involved in teaching science and provides lesson plans linked to the 5-14 guidelines, a tutorial on browsing the web and a list of components and materials. Teachers can obtain further assistance and advice via email, telephone or fax.

2 This evaluation reports on the pilot study that constitutes the second phase of SOLSN. This version of SOLSN bears little resemblance to the original as it was decided to make changes to the technology and to the content, although its aims remain the same.

3 The same three authorities (Edinburgh, Fife and West Lothian) and ten of the original eleven schools have been involved in both phases. A total of 24 teachers has participated in Phase 2: nine were involved in the earlier phase and fifteen teachers were new to the project.

4 The core of the material is derived from a package of paper-based support material produced by Renfrewshire Council: the *5-14 Science Programmes of Study Pack*. The content of the CD-ROM is focused on the science elements of the 5-14 Guidelines and arranged by primary 1-7 levels. The CD-ROM also provides a tutorial on browsing the web, newsletters and a list of components and materials. Teachers can obtain further assistance and advice from the SOLSN team by email, telephone or fax.

5 The SOLSN CD-ROM is structured like a website and provides links within the site and to third party resources on the web (either live or stored on the disc) so it can operate either on a stand-alone basis or make use of internet connections. Utilities are provided to facilitate the use of various web browsers across different platforms.

6 One laptop computer with a CD-ROM drive was provided for each school participating in the pilot study on a 'no strings attached' basis.

The aims of SOLSN

7 The SOLSN project has three main aims:

- to support Scottish primary teachers to improve their own understanding of science, assisting them in their professional development

- to seek to improve standards in the learning and teaching of science at the 5-14 level
- to improve liaison and continuity in the experiences of pupils across the primary and early secondary stages.

The evaluation

8 This evaluation assesses the extent to which the SOLSN pilot study has fulfilled its objectives and evaluates the viability of expanding this service.

9 The study took place from November 1999 to April 2000 with most of the research activity taking place from January to April. The main methods of data collection were visits to all ten schools to interview 21 participating teachers. Teachers were asked to log usage and we collected 14 diaries. We conducted 16 telephone interviews with key stakeholder representatives and ten people attended the focus group meeting.

10 Teachers' attitudes to SOLSN changed in the month or so which elapsed between the interviews and collecting the diaries. They became more positive once they had more time to familiarise themselves with SOLSN's contents and the technology became fully operational.

The CD-ROM

11 The CD-ROM is used mainly to access resources derived from the Renfrewshire science pack, which organises its material around lesson plans with worksheets. Teachers welcomed a CD-ROM version of the materials although the worksheets had not been extensively used. The SOLSN lesson plans were not used directly from the pack but were used to improve or update existing plans. Deadlines for the production of CD-ROMs meant that some key elements of the original Renfrewshire materials had to be omitted. It is important to note that the comments in this report refer to the CD-ROM materials rather than the original Renfrewshire *5-14 Science Programmes of Study Pack*.

12 The following list describes the main strengths of the SOLSN CD-ROM from the teachers' perspectives:

- ✔ The Renfrewshire Science Pack is geared to the 5-14 curriculum and uses terms recognised by teachers. It has been useful as a planning tool and for lesson preparation.
- ✔ It is easier to show links between guidelines, activities and resources on a CD-ROM than on paper.
- ✔ The web links give easy access to new resources.
- ✔ Teachers can learn how to use web browsers whilst interacting with a CD-ROM.
- ✔ It provides continuing professional development materials for both science and ICT and is a popular medium as it can be used out of school.
- ✔ It is an efficient way in which to store information and is easy to carry around.

13 The following list describes the main shortcomings of the SOLSN CD-ROM from the teachers' perspectives:

- ✗ Teachers need some ICT competence and confidence to get the most out of the CD-ROM and there is a need for troubleshooting advice.
- ✗ There are usability problems caused by interface design and so teachers were unaware of some features.
- ✗ A larger bank of materials is required, including more frequently asked questions.
- ✗ The quality of the worksheets could be improved and there is too much emphasis on worksheets at the cost of investigations and other learning activities.
- ✗ It needs more content which would be suitable for children to access as well as ways of encouraging children to use ICT in science lessons.
- ✗ It does not include the Renfrewshire overview and guidance material for science coordinators. This would provide additional information that would be helpful for primary/secondary transition.
- ✗ It does not provide sufficient information that would be helpful for assessment.

The extent to which SOLSN supports primary teachers to develop their understanding of science

14 Slightly more than half of the teachers interviewed claimed that SOLSN increased their confidence in teaching science and increased their understanding of the concepts.

➤ Recommendations

15 The materials derived from the Renfrewshire Science Pack should be restructured to provide different views of the content depending on the teacher's needs. This should include arranging the content by Primary 1-7 levels, by A-F levels and by curriculum area.

16 Teachers need personalised help in addition to the support provided by the SOLSN CD-ROM. Members of a local authority support team should have a specific time allocation for SOLSN and the opportunity to offer face-to-face help.

17 The materials currently available on SOLSN should be augmented and extended so that teachers have more opportunities to develop their own understanding.

The extent to which SOLSN improves standards in the teaching of science at 5-14

18 Only a third of teachers interviewed considered that their understanding of the methods of teaching science had changed as a result of using SOLSN over the period of the trial.

➤ Recommendations

19 Provide materials that include advice about teaching and learning strategies.

20 Incorporate a feature in a new online SOLSN that is similar to the *café* in Phase 1 as a way of encouraging discussion and reflection.

21 Extend the original project brief by providing materials to encourage the use of ICT in science by children.

22 Consider providing interactive planning sheets linked to assessment, evaluation and the next stage of planning.

23 Provide materials that support assessment.

The extent to which SOLSN improves continuity between primary and secondary stages

24 SOLSN has not met this objective, other than by secondary school involvement in training days.

➤ Recommendation

25 Content relevant to the primary/secondary transition should be identified or produced.

The viability of expanding SOLSN beyond the participants of the pilot study

26 Despite the various reservations and shortcomings listed above, the achievements of the project to date mean that support amongst the various stakeholders and partners for continuing with SOLSN remains strong. Scaling up the project from a small base will present serious challenges. Nonetheless, a majority of those involved at the focus group meetings were supportive of proceeding to the next development phase and thence to a national roll-out. What concerns were raised were connected with timescales, ICT training, connectivity and continuity of funding.

➤ Recommendations: the management of extending SOLSN

27 The current hybrid model of a CD-ROM with both cached web resources and external links should be maintained for now but with a target of 2002 for going online. In the meantime, the CD-ROM should be updated to take account of revisions to 5-14 guidelines and additional material sourced or commissioned.

28 Development work for going online in 2002 should be conducted in parallel with refinements to the CD-ROM. This includes addressing new training needs, Intellectual Property Rights and funding.

29 There is a need for funded support for both the technical aspects of using the CD-ROM and for the pedagogical and curricular areas.

30 Intellectual Property Rights should be managed centrally even if the management of other aspects of SOLSN is devolved. A person with specific responsibility for managing and commissioning content is required.

31 Consideration should be given to a three-year funding commitment to provide continuing support for the present implementation of SOLSN and its transition to going back online.

➤ Recommendations: usability

32 Conduct or commission formal usability testing.

33 Redesign the interface based on findings of the usability testing.

34 Extend the scope of the current tutorial to include the use of search engines and other topics suggested by teachers. A paper-based manual should also be provided.

1: Introduction

Background

1.1 The Science Online Support Network (SOLSN) is managed by SSERC (Scottish Schools Equipment Research Centre) and is currently provided in the form of a CD-ROM with website links to science resources. It is intended to support teachers in primary schools who are involved in teaching science and provides lesson plans linked to the 5-14 guidelines, a tutorial on browsing the web and a list of components and materials. Teachers can obtain further assistance and advice via email, telephone or fax.

1.2 SOLSN is being developed by a partnership which includes the Scottish Executive Education Department and the City of Edinburgh, Fife and West Lothian councils in addition to SSERC.

Phase 1: the feasibility study

1.3 SOLSN began in April 1997 with five CDi discs designed to support staff development in primary school science. The material had already been produced by the Scottish Interactive Technology Centre (SITC) at Moray House Institute of Education in conjunction with the BBC and the Scottish Office Education and Industry Department.

1.4 The discs and a CDi player were made available to 11 schools and supplemented by a website to encourage peer support through the internet. This feasibility study constituted Phase 1 of SOLSN and during this period (1997/1998) it was managed by SITC.

1.5 The SOLSN website provided a *café* which provided email links to science educators who fulfilled the role of helpers, a *library* which provided links to other websites and provided downloadable documents, a *forum* for reading and posting messages and a *prep room* for displaying work. These features were accessible only to teachers in the trial schools and the helpers.

1.6 The major obstacles to further progress were identified in the evaluation report of the feasibility study and by SOLSN's project team's school visits as inadequate access to equipment, inadequate connectivity and insufficient training in the use of technology to benefit from a website. (See Harlen and Schilling, 1998 and STS/ Scottish Schools Equipment Research Centre, 1999.) This inhibited the possibilities for its day-to-day applications in learning and teaching and there were problems with the role and management of the helpers. The main advantage of the CDi materials was their use of video but there were problems with indexing and searching content and the lack of a curriculum framework. Nevertheless, the

evaluation found that SOLSN had great potential for helping primary teachers to improve practice and raise standards in science.

Phase 2: the pilot study

1.7 As a response to the findings from Phase 1, it was decided to make changes both to the technology and to the content. SOLSN's development and implementation of the changes under the management of SSERC constitutes the pilot study (Phase 2) that is the focus of this evaluation.

1.8 It was decided to address the *technological* problems by making available laptop computers with a CD-ROM drive as a means of improving access. The online dimension of SOLSN was suspended as an interim measure until schools and teachers had sufficient access to the technology and appropriate training.

1.9 The chosen solution was to produce a cross-platform (PC and Apple) CD-ROM using web browser technology which would provide links within the site and to third party resources on the web (either live or cached). This would mean the CD-ROM could operate either on a stand-alone basis or make use of internet connections. There was no equivalent of the *café* or *forum* and, because the online dimension was much diminished, there was no need for helpers to fulfil the same role as they had in phase 1. Local authority partners were instead requested to provide their own pilot schools with enhanced technical support and other back up.

1.10 Site *content* would be redesigned to meet the practical needs of teachers so that it was focused on the science elements of the 5-14 Guidelines and tied in to levels and assessment strategies.

1.11 The chosen solution was to base content for the CD-ROM on a package of support material produced by primary and secondary teachers in Renfrewshire Council: the *5-14 Science Programmes of Study Pack*. These materials are generally referred to in this report as the Renfrewshire Science Pack.

Features of the CD-ROM

1.12 The aim of the original authors of the Renfrewshire Science Pack, as stated on the *Background to Primary Guides*, was to 'produce material that was as comprehensive as possible but which could be easily accessed and used by teachers in their everyday work, whilst ensuring that they could be confident that the classwork being undertaken would satisfy the requirements of the National Guidelines. The science pack that has been produced represents the best advice that can currently be offered to teachers in a format that is easily managed and can be used both as programmes of study and as a planning tool with the facility to be adapted and amended to suit individual

requirements or changing needs. The Science Pack is intended to be a framework upon which schools can confidently plan effective learning and teaching experiences for pupils.'

1.13 In addition to interlinked and searchable material derived from the Renfrewshire Science Pack, other features provided by SSERC are described as including 'the identification of progression within each Attainment Outcome as well as a comprehensive equipment list with suppliers and price for each of the Key Feature units. The contents of some of the SSERC Interactive Primary Newsletters are also referenced from the relevant lesson outlines. Also included are direct E-mail links to SSERC staff as well as a comprehensive illustrated Components & Materials List.'

The aims of SOLSN

1.14 The SOLSN project now has three major objectives. As described in *Science & Technology Equipment News*, No. 18, September 1999, these are to:

- support Scottish primary teachers to improve their own understanding of science, assisting them in their professional development
- seek to improve standards in the learning and teaching of science at the 5-14 level
- improve liaison and continuity in the experiences of pupils across the primary and early secondary stages.

Improving science education 5-14

1.15 The publication *Improving Science Education 5-14* (Scottish Executive Education Department, 1999) highlights concerns about the quality of pupils' science education in Scotland. However, the inception of the SOLSN pilot phase predates both the SCCC consultation exercise on revised guidelines for Environmental Studies and the SEED report.

1.16 To address these concerns HMI recommend in the report that appropriate bodies working with education authorities should:

- produce assessment materials in science to support teachers' judgements in measuring pupils' progress and attainment against more clearly defined attainment targets for teaching and learning
- consider how more flexible use might be made of the specialist skills of teachers in both primary and secondary sectors to improve pupils' attainment in science
- consider what further forms of support, including staff development, would be most effective in helping to address primary teachers' lack of confidence and competence in teaching science
- provide examples of good quality 5-14 science courses. These courses should be based on the revised 5-14 guidelines for environmental studies

and should take account of the advice offered in this report about effective learning and teaching.

1.17 This study uses these recommendations as one way of evaluating SOLSN's effectiveness and they will be referred to throughout this report. However, *Improving Science Education* was published in October 1999 and so its recommendations cannot be used as the only measure of SOLSN's success given that the design and production work for the CD-ROM was carried out in the period March to August 1999.

Organisation of the report

1.18 After describing methods for collecting and analysing data in Chapter 2 the main findings of the study are provided in Chapters 3, 4 and 5. Conclusions and recommendations are provided in Chapter 6.

2: The evaluation

Background

2.1 The Scottish Council for Research in Education (SCRE) was commissioned by the Scottish Executive Education Department to assess the extent to which SOLSN has met its objectives and to evaluate the viability of expanding the service.

2.2 As already noted, an evaluation of the feasibility study was published in 1998 (Harlen and Schilling, 1998). This report provides an evaluation of the pilot study that took place between November 1999 and April 2000.

2.3 An advisory group was constituted to represent the interests of the SEED ICT Schools Team, the inspectorate, SSERC and teachers (Appendix 3). The group met three times in the course of the study.

2.4 The study was designed to ensure that as many representatives of the various stakeholders as possible had a voice in the evaluation. Stakeholders include the SEED Schools ICT Team, the SOLSN project team and steering committee, the teachers and learners directly involved in the study and the local authorities. All were involved in the evaluation process by means of interviews and the focus groups.

2.5 The same three authorities (Edinburgh, Fife and West Lothian) have been involved in both phases. Ten of the original eleven schools remained committed to SOLSN for Phase 2.

2.6 A total of 24 teachers has been involved in Phase 2, made up of nine who were involved in Phase 1 and fifteen teachers who were new to the project. Appendix 1 provides information on participating schools and teachers.

Aims and objectives

2.7 The aims of the evaluation were to:

- assess the extent to which SOLSN supports Scottish primary teachers develop their understanding of science, improves standards in the teaching of science at 5-14 level and improves continuity between primary and secondary stages
- evaluate the viability of expanding SOLSN beyond the participants of the pilot study.

2.8 These aims were achieved by:

- evaluating the operational, managerial and pedagogical aspects of SOLSN

- evaluating the use of this technology for the delivery of teachers' continuing professional development
- providing an opportunity for stakeholders' views to be included in the evaluation.

Collecting evidence

2.9 There were two main sources of evidence: the teachers in the trial schools and other stakeholders, who represented a range of interests. Documents such as minutes of the SOLSN management groups and records of training sessions were also used as sources of evidence.

2.10 A total of 21 teachers was interviewed in person and one headteacher was interviewed by telephone.

2.11 Teachers were asked to keep a diary for the duration of the trial, logging times when SOLSN was used, why they were using it and commenting on the content and its usefulness. The diaries were intended to provide data which would supplement that produced from the teachers' interviews. Fourteen diaries were returned to the evaluation team at the end of the pilot study period.

2.12 Sixteen telephone interviews were conducted with stakeholders' representatives (Appendix 2). Different clusters of questions were asked depending on their area of expertise and covered topics such as intellectual property rights (IPR), the long-term viability of SOLSN and pedagogical impact.

2.13 The telephone interviews were used in part as a scoping exercise for the focus groups. Ten participants attended a meeting in March 2000 with the purpose of providing recommendations to the evaluation team. They were divided into two focus groups to consider the desirability of rolling out SOLSN across Scotland, the issues involved in the transition from a project based in three authorities to one which involves 32 authorities, how these issues are best addressed and a range of models for doing this. Appendix 2 shows the membership of the focus groups. Participants were suggested by the advisory group for the evaluation and include teachers, representatives from the three local authority partners and Renfrewshire and the National Grid for Learning (NGfL) team.

Analysing evidence

2.14 Quantitative data has been derived primarily from the 21 interviews with teachers. The data are presented as absolute values, not percentages, because differences are not statistically significant on a dataset of this size. Qualitative data has been thematically analysed by respondent group.

2.15 We used the headings managerial, operational and pedagogical to organise data analysis. Although considered as separate categories, none of these aspects can be examined in isolation and this form of analysis points to the interrelationships involved in introducing new technologies into learning environments.

2.16 *Managerial* includes those aspects of the study which are largely outwith the teachers' control. It includes (a) management of the trial by SSERC and (b) the impact of school or local authority management on teachers' use of SOLSN.

2.17 The impact of management by SSERC includes the effectiveness of project management, whether the training offered by the project team met teachers' needs, IPR issues and whether SOLSN represents a model which can be extended across Scotland. The impact of local management either within or outwith the school includes levels of resourcing, access issues and support from the local authority or school senior management team.

2.18 *Operational* includes issues pertaining to the operation and use of the hardware and software. It includes reliability and usability with reference to the competence and confidence of the teachers involved and some issues relating to whether SOLSN operates best as an offline or online service.

2.19 *Pedagogical* includes an analysis of whether SOLSN supports teachers in developing their understanding of science, whether it is likely to improve standards in the teaching of science at 5-14 level and its role in improving continuity between primary and secondary stages. This encompasses SOLSN's impact on the organisation of teaching and learning science, whether the materials meet teachers' needs and the integration of SOLSN into lesson planning and programmes of study.

Timetable

2.20 A timetable for the study is provided in Appendix 4. The evaluation took place over the period from November 1999 to April 2000, with most research activity in the spring term 2000.

3: Operational aspects

Teachers and ICT

3.1 The participants in this trial were a mainly self-selecting group of teachers who were aware from the outset that it involved using information and communication technology (ICT) as an aid to teaching science. Further, nine of the 21 teachers were involved in phase 1 of SOLSN. At least a quarter of them had a computer at home as five teachers reported using it for accessing SOLSN. We can therefore infer that these teachers had levels of competence and confidence with ICT that were likely to be higher than for many teachers in primary schools.

3.2 Nevertheless, teachers' experience with ICT is still limited. Many of them found it difficult to answer the interview question on whether they would prefer SOLSN to continue as it is now or to become an entirely web-based service because they could not visualise the differences.

3.3 A number of the points raised in this chapter could equally be described as management issues but they have been covered here as the extent to which SOLSN was used, the teachers' experiences of using the material and their ICT competence and confidence is determined by their access to it.

Access

3.4 Provision of equipment and access to it were unevenly distributed. Each participating school was provided with a 'no strings attached' laptop computer, although teachers received them at different times over the course of the trial in the different authorities. This meant that some schools had only just received their laptops when interviews were conducted in mid-January 2000 and had not developed competence with them. All the schools that had been in possession of the laptops for longer were using them and found that the use of SOLSN was much easier and more attractive than previously. Few of the schools gave pupils access to the laptops.

3.5 Half of the teachers interviewed were using SOLSN at home and they were from the schools that had received the laptops. These teachers said that they did not have time to use SOLSN in school. This finding reinforces the belief that the laptops make a positive contribution to the uptake of SOLSN by teachers, although teachers who are not online at home cannot utilise the live links to websites.

3.6 Access to the CD-ROM itself was also variable. Some teachers were disappointed that they did not have their own copy and this may have limited usage. Schools in one authority received one for each teacher as the

science adviser pressed extra copies: in one school the CD-ROM was made available over the school's network.

3.7 Some situations were beyond the control of the SOLSN team but nevertheless had an impact on the pilot study. Teachers in West Lothian received their individual email addresses as late as April 2000 and this limited the opportunities for them to liaise with each other or with the SOLSN team. At the time of one of the training days in November 1999 only a quarter of teachers had access to a scanner in their school; this could partly account for the lack of materials sent in by teachers for inclusion on the CD-ROM.

Use of links to websites

3.8 At the time of the interviews, some schools had only just become connected to the internet and others were still unable to get access. About half (11) the teachers interviewed had used the CD-ROM's links to websites, five of whom had accessed the internet from home. Only six teachers used school links to the internet. Of those who had used the links some said that it took a long time to get connected, but once connected the live links from the CD-ROM were very quick. So far, there has been no problem with maintaining links to websites, but in the longer term it will be necessary to establish whose responsibility it is to check them at regular intervals.

3.9 Some of the filters were over-restrictive as the authority had set them at a level suitable for children's access to the internet and had not taken account of teachers' access requirements. This meant that a website containing information on reproduction, for instance, could not be accessed. As online access for teachers and pupils increases, this is an area which requires further consideration.

3.10 The majority of teachers said that they would prefer a hybrid system with SOLSN remaining as a CD-ROM with links to web sites. The main reasons given for wanting to retain the CD-ROM were that it is easy to take home and, as all schools are not yet online, the teachers do not feel confident about methods of accessing the internet. Teachers had experienced the CD-ROM and liked it whereas they did not have a clear picture of what would be offered in an online version. Discussion at the focus group reinforced the belief that the CD-ROM is good for swift, straightforward access.

3.11 By the time the diaries were collected at the end of the evaluation period more teachers were using the CD-ROM and accessing the websites and the diary entries are generally more positive than the interviews indicate. This suggests that some of the interviews were conducted too early to get a true picture of how usage would develop: many teachers had been too busy at the end of the Christmas term 1999 to familiarise themselves with SOLSN's contents and not everybody had access to a laptop computer.

3.12 As only a month or so elapsed between some of the interviews and collecting the diaries this indicates how quickly attitudes can change given easy access to the hardware and enough time to explore SOLSN's content. However, it should be noted that we had fewer diaries (14) than interviews (21) and some of the diaries were from teachers who had not been notified to us as participating in the trial and so had not been interviewed. As those teachers had joined the trial after it started, presumably after seeing SOLSN in use by their colleagues, it is possible that they were more enthusiastic users.

3.13 At the time of the interviews most of the teachers did not seem to appreciate the potential for children to have interactive learning experiences by using the CD-ROM to access the web sites.

Usability

3.14 This section provides a critique of the SOLSN CD-ROM's usability (ie how easy it is to use the features and functions). It indicates a number of shortcomings but readers should bear in mind that the disc has been produced by a small team that had other responsibilities during the software development phase and that members of the team had to contend with different computer platforms and web browsers across the partner authorities.

3.15 It is outwith the scope of this evaluation to comment on value for money aspects of the SOLSN project but the CD-ROM demonstrates typical problems relating to the lack of professional design input. This suggests a need for some full time commitment to such development tasks and funds to allow for buying-in professional design skills.

3.16 It should be noted that usability was not an issue for teachers. There were occasional references to difficulties in finding specific material or getting lost when browsing through the content but no consistent criticisms. Indeed there was demand for extra copies once teachers outwith the pilot study became aware of the disc.

3.17 The justification for commenting on usability aspects of the SOLSN CD-ROM is based on the evaluation team's perception that this is an area that is difficult for teachers to articulate. This is because some teachers are not familiar with the vocabulary for describing computer interfaces and, at this stage, they do not generally have enough experience to be able to make comparisons between different websites or CD-ROMs. They may be aware of minor frustrations when using the disc but many novice users will assume that any problems they encounter are their own fault, not a design problem.

3.18 The following commentary is based on browsing the disc with an awareness of navigational and design issues rather than formal usability testing. This is an inadequate approach because deeper design problems may only emerge when products are used by real users carrying out real tasks. If a user browses materials without a specific task in mind they will tend to follow the default paths provided by the design and they will not unearth all the usability problems.

3.19 Usability has been addressed by the SOLSN team in terms of *content* by establishing the curriculum group to represent teachers' needs. They have a good profile of their client group and a good understanding of the tasks for which the materials will be used. Evaluation sheets issued at training days provide the team with information on teachers' previous training in ICT and establish what equipment is available in schools.

3.20 However, there is no apparent method for addressing usability in terms of interface design. Because of the need to produce the CD-ROM to a tight schedule this has been limited to in-house testing by staff at SSERC and to requesting feedback on a prototype with a single redesign stage before widespread distribution of the disc and soliciting comments at training days. As explained above, this is unlikely to provide the depth of information required.

3.21 The SOLSN team needs to conduct or commission formal usability testing. This should take the form of observing a range of teachers using the CD-ROM for authentic tasks and capturing data through 'think aloud' protocols or stimulated recall. The first of these has the disadvantage of introducing artifice into a situation which should be as realistic as possible as it requires the user to explain their thought processes and decisions whilst using the computer. The second method suffers from intrusion of a video camera but the user does not provide a commentary until looking at a video of their own use.

3.22 The following areas form the foundation of current thinking on usability testing:

- the consistency of interface design
- whether screen designs match identified requirements
- whether the structure of the online materials is understandable navigable
- whether the software matches users' concepts of interactivity
- the provision and design of online help and user guides
- how easy it is to download materials.

3.23 There are many other aspects to usability testing. This commentary is based on accessing just a few pages and is restricted to itemising a few salient points as an indication of the need for further development work.

Design of SOLSN

3.24 SOLSN is distributed on a CD-ROM but uses web browser software to structure the material. Typical browsing time on SOLSN was about 30 minutes so this design decision is good for teachers learning how to use browsers without the expense of being online. Once teachers become confident using the CD-ROM and have access to the internet they can use the links to pre-selected resources. This provides a semi-controlled environment so browsing is easier, the risk of getting lost is reduced and teachers can avoid having to deal with the plug-ins found on some sites. This strategy should improve confidence in using the web in other contexts and also has the benefit of ensuring that teachers are prepared for SOLSN if and when it goes back online.

3.25 The written user guide for SOLSN consists of an illustrated 8-page newsletter. Fife has produced a guide for PCs only but it has not been widely distributed. Some teachers seemed unaware of the newsletter, perhaps because they had not attended a training session, and eleven out of twenty teachers said they would have found a written guide useful. This lack of information means that even opening the CD-ROM can be problematic: on the Mac version the user should click on Go2.htm to get to the introductory screen. This is not intuitive and could be off-putting for a novice user. One third of teachers said they had difficulty getting the CD-ROM up and running.

3.26 It leads to a screen that allows the user to select SOLSN Net or the SOLSN Net Disc Guide. This highlights a problem with consistency of terminology: SOLSN is never referred to as SOLSN Net in speech or documentation and this could also be confusing. Consistency of terminology, colour coding and icons is a fundamental aspect of good website design but is particularly important in a context where several weeks or longer may elapse between visits to the content and even expert users may have forgotten how they accessed specific parts of the content.

3.27 The introduction screen for SOLSN Net has a busy appearance with nine separate boxes, at least 18 clickable points of entry and at least six colours for text. Two of the boxes are yellow, one is pink and five are blue but there is no apparent rationale for this. The image of the surfer associated with the SOLSN Net Disc Guide on the previous screen now has different text attached to it and for Netscape users there is nothing to indicate that 'Surf's Up' accompanied by a clip-art figure of a surfer will take the user to a tutorial on using browsers.

3.28 The tutorial is useful but teachers would probably benefit from help on using search engines. The SOLSN-dedicated search engine needs to be much more visible (most people were unaware of it) and easier to access than the current key combination of control F or command F.

3.29 There are a number of typographical errors in the text and occasional use of confusing syntax. This is particularly noticeable in the FAQs (Frequently Asked Questions) and on the tutorial. Whereas typos are considered acceptable in email, which was probably the original medium for the FAQ responses, a website or CD-ROM is equivalent to a traditional publication in terms of its requirements for accuracy and clarity. Introducing a feature whereby all the FAQs could be accessed from one entry point would probably be helpful.

3.30 The introduction screen for the material derived from the Renfrewshire Science Pack displays at least eight colours for text plus dynamic text. Colour is used inconsistently: users cannot click on red text when it is used for 'Interactive' but can when it is used for 'Net' in SOLSN Net or SSERC Equipment List. There are a number of different ways of accessing information: two drop down menus, hyperlinks and clickable icons. It is probably not clear to novice users what 'minimise' means in the context of the drop down menu.

3.31 There are general problems relating to the conventions of text colour. A clearer colour code is required to make a distinction between links to cached resources and links to external websites. Blue text, which by convention shows external links, indicates links to material on the CD-ROM (and is often used for the word SOLSN, suggesting it is hyperlinked when it is not). A blue/green colour is used for links to external websites.

3.32 More navigational support is required. It is difficult to locate the user's position in the information space or see the route taken and too many clicks are required to access some of the content. Consideration should be given to providing alternative ways of structuring access to the lesson planning materials to meet a range of users' needs. They are currently structured according to school year group rather than by topic so it is difficult to see progression without clicking on a sequence of other year group sections.

3.33 The pilot study was without major technical difficulties and the hardware and software were mainly reliable and robust.

4: Managerial aspects

Introduction

4.1 As a response to concerns that SOLSN was too technology driven in its earlier stages, it was decided to reorganise the management structure. The revised structure includes a curriculum group and a technology group with a steering committee which includes the chairs of both groups along with external advisors. The curriculum group represents SOLSN's 'clients', who are mainly teachers in primary schools. Its main function is to present requirements to the technology group, which is tasked with translating them into implementable features and functions. The curriculum group, in turn, provides some evaluation of the product development.

4.2 Participants in the evaluation study appeared to be satisfied with these arrangements and saw them as a great improvement on the earlier management model. However, findings in the section on usability (3.14–3.33) demonstrate some of the limitations of expecting teachers to provide a design brief for implementation by others.

4.3 This model has some features in common with the method of participatory design which evolved in Scandinavia as a response to the problems incurred when computer systems are designed without much reference to the people who will actually use them or their existing work practices. Panels of workers convene to discuss their requirements and make recommendations on the design features they want. This is a useful corrective to a technology driven approach which imposes computers on people and expects the users to adapt to the computers rather than the other way round but there are some shortcomings to using these methods.

4.4 One problem is that it is difficult for people who do not have much technical knowledge to articulate design requirements, partly because they are not likely to know what is possible beyond their own experience of using computers. This means that design briefs are likely to be conservative rather than forward-looking. Although they can express requirements in terms of whether the content meets curriculum needs it is not so realistic to expect them to inform more detailed decisions such as the design of the interface and structuring the information space. At present, there does not seem to be a mechanism for testing the usability of SOLSN in these terms as this requires more communication between teachers and developers than the present management structure allows. One approach could be that adopted by the Scottish Council for Educational Technology during the 1990s in which teams of designers and teachers worked in partnership during the software development phase.

4.5 Nevertheless, members of the technical group spend a lot of time visiting schools and participating in training sessions and have a well-developed sense of what is useful for teachers. SOLSN has developed iteratively from the feasibility study and its evaluation to the pilot study and its evaluation but more detailed usability testing is necessary.

Training and support

4.6 The training days in November were praised by the teachers. They appreciated having time to look at the CD-ROM and develop awareness of it as a resource, although some said that they would have liked a written guide to take away.

4.7 The success of SOLSN depends on the active support of the senior management team within the school. Science does not currently appear on many school development plans and so it is not seen as a training priority, although teachers hoped that this will change as a result of the publication of *Improving Science Education* (SEED, 1999).

4.8 The support of the local authority is also important and advisers with responsibility for ICT need to know about SOLSN.

Helpers

4.9 Teachers who needed assistance tended to contact local authority advisers. These advisers contacted SSERC if necessary and SSERC dealt with any problems quickly and efficiently. 'Helper' did not really exist as a role in this phase as it had in Phase 1 when the online nature of SOLSN at a time of low connectivity meant that many people experienced problems.

4.10 Some of the teachers remembered the *café* (email links to helpers) and *forum* (exchange of messages) from the original online SOLSN and said that these features had been a good idea. A reinstatement of these features would give local contact with help groups within a cluster or local authority.

4.11 There is a need for help in two categories: with technical aspects of using the CD-ROM and with the pedagogical and curricular areas and it is not likely that help in these two areas can be provided by the same person. The focus group raised the importance of face-to-face help but this is expensive. A compromise model was used in the original pilot where helpers were introduced personally at launch meetings and then their photographs appeared on the website where they could be contacted.

Relationship to New Opportunities Fund training

4.12 Less than half of the group had received New Opportunities Fund training in ICT and the majority of the teachers had not received any information about it. Materials produced by an adviser in Fife demonstrate that SOLSN is a useful tool for using within New Opportunities Fund training in ICT as it is compatible with many of the targets.

Intellectual Property Rights

4.13 Information in this section and the following section on extending SOLSN has primarily been taken from the telephone interviews and focus groups. These sections discuss issues that are the proper concern of the SOLSN project management team but also reach beyond their control. A summary is provided here to inform future decision-making.

4.14 The Renfrewshire Science Pack originated in a paper format and constitutes the core of the SOLSN content. The materials have been enhanced in the transfer to a CD-ROM by the addition of links between 5-14 guidelines, activities and resources that could not be achieved on paper.

4.15 Intellectual Property Rights (IPR) issues are relatively contained as long as SOLSN operates on its small scale of ten schools in three authorities. Although time-consuming, it was possible to gain clearance to use other websites as resources on the SOLSN disc provided access was for non-commercial use. Similarly, the individual schools involved in the pilot study have not needed licences to access the material derived from the Renfrewshire Science Pack, although authorities who want to use SOLSN must buy a licence.

4.16 The issue of IPR is more acute in the context of SOLSN rolling out on a national basis. This is because not only will the users extend to schools and authorities who do not currently hold a licence but the content is also likely to be more wide-ranging than at present. This means there is the potential for different claims to ownership of publicly funded materials.

4.17 The revised content could encompass both local authority and teacher-produced materials, whether they are extensions of the Renfrewshire Science Pack or not, and commercially produced materials. As Edinburgh and Renfrewshire are currently collaborating on assessment materials there are also IPR issues relating to co-produced materials. Further, it is not clear what the situation is with regard to existing Renfrewshire Science Pack materials (such as for S1 and S2, ideas for investigations and notes for coordinators) which do not currently form part of SOLSN.

4.18 These concerns and the prospect of extended negotiations conflict with the generally held desire to broaden both the content of and access to SOLSN so that it provides a good body of material which is of proven value to

teachers and available on the NGfL. Several respondents stressed the need for a shared vision and goodwill between the various interest groups as the problems are not likely to be easily resolved, partly because there are no clear precedents. The consensus of opinion was that IPR should be dealt with by a single administrative unit even if the management of other aspects of SOLSN (see table 4.1) is devolved.

4.19 One partial solution to this problem is for SOLSN to commission its own materials. This is likely to be more expensive but the model used by the Scottish Virtual Teacher Centre could be adopted: material is commissioned on the basis that the SVTC owns the copyright if it is used for non-commercial purposes. Findings in Chapter 5 suggest teachers would appreciate tailor-made materials but they would like them to be provided in addition to the Renfrewshire Science Pack. No respondent suggested that a Phase 3 version of SOLSN should dispense with the Science Pack and the focus groups suggested it should be retained, along with exploring the potential of repurposing some of the material on the original CDi discs. Both options require finding a solution to IPR problems.

Teacher-produced materials

4.20 One of SOLSN's aims is to encourage teachers to share good practice by submitting their own lesson plans and worksheets but this also has an IPR dimension. The approach currently taken by the NGfL is that if material has been produced at an authority's expense (for instance, by a teacher on secondment or in contracted time) then copyright belongs to that authority and teachers need its signed permission. If teachers produce the material in their own time then those claims cannot be made.

4.21 So far, teachers have not produced much for SOLSN, other than some examples of lesson plans and pupils' work, but it is acknowledged that such materials need to be evaluated in terms of presentation and pedagogy before making a decision on whether to accept or decline submissions. This needs handling sensitively: some teachers expect their material to be improved but others would be offended by changes to it.

4.22 The Scottish NGfL team have decided not to use an approval system because it would require detailed evaluation procedures and there is no absolute standard for content because its usefulness and usability vary across contexts. Current NGfL policy is to apply the concept of 'relative value' by describing the source and content and leaving users to determine value. There is currently no work produced by pupils on the SVTC other than some competition materials in the public domain so there is no convention for assigning IPR to pupils' work.

Extending SOLSN

4.23 The two key areas in a discussion of the viability of extending SOLSN to become a national resource are (a) deciding whether going back online is an essential element of rolling out and (b) agreeing appropriate management models for a project involving thirty two rather than three authorities. To some extent, decisions about management of an extended SOLSN depend on technological decisions.

The technology

4.24 In its first phase, SOLSN operated primarily as an online network with a separate set of CDi discs. The feasibility study concluded that the existing levels of teachers' competence and confidence with ICT and the general levels of connectivity in primary schools at that time meant that SOLSN's potential could not be fully exploited.

4.25 As a response to those findings it was agreed that SOLSN would consist of a CD-ROM with both cached resources and links to external websites. This was originally intended to be an interim measure until levels of training, access and connectivity could enable a fully online SOLSN to take effect. As the second phase has drawn to a close, the question of whether SOLSN should go back online has re-emerged.

4.26 If this decision were to rest entirely with teachers, responses to interviews suggest most of them prefer the current hybrid model of the CD-ROM with optional links to the internet (*See* 3.10). Other stakeholders would prefer to return to the online model with which SOLSN originated and which is encapsulated in its name (Science *On-Line* Support Network).

4.27 The management team, however, recognise that the curriculum group was established to ensure that teachers' views are represented and that the project is needs driven. As a response to this divergence of views between teachers and others it was agreed that the evaluation team would convene focus groups to discuss the single issue of rolling out SOLSN in a new phase of the project with the aim of identifying the key issues and arriving at a consensus on the way forward. (*See* Appendix 2 and 2.13).

4.28 The following points were made in favour of keeping SOLSN in its current form:

- the lack of teachers' ICT skills is seen as the major constraint on going back online, especially as the teachers who have been involved with SOLSN are probably not representative of general levels of ICT skills in primary schools
- as most teachers do not produce materials for SOLSN it is not necessary to have the technical capability to upload materials

- teachers like to use SOLSN from home. If it were only available online a significant proportion of teachers would be denied access other than at school.

4.29 The following points were made in favour of going back online:

- this is the way that ICT generally is developing and SOLSN should move with the times
- it is easier to update content
- teachers will make use of it, even if the conditions are not optimal, if the content is perceived to be valuable
- the requirements for features such as bulletin boards and the opportunity to receive online help.

4.30 Participants considered the extent to which teachers would use features such as bulletin boards and email discussion lists as part of this discussion. The point was made that the SVTC and SCCC bulletin boards have almost collapsed due to the lack of teacher participation, even though both websites are heavily used, because they need a critical mass of *actively* involved teachers. However, they were seen as a positive feature once teachers had sufficient confidence to use them and they were considered to be more likely to be successful if they were localised. Email discussion lists will probably be more successful in the short term because it is easier to choose an active or passive role and email is seen more frequently, although their success still depends on every teacher having an em il account, access to a suitable machine and the confidence to use email.

Managing an extended SOLSN

4.31 It was fairly straightforward to reach consensus on if and when SOLSN should go back online. However, the issue of how an extended online SOLSN should be managed was more contentious and discussion revolved mainly around issues of which aspects should be centralised and which should be devolved.

4.32 SOLSN currently uses a centralised management model and this is considered to be appropriate for a project that includes three authorities in a fairly limited geographical area. At the moment, a strong feature of SOLSN is that its management team is in touch with its clients and teachers feel some ownership of the project; the danger of centralising management if SOLSN is scaled-up is that these benefits will be lost.

4.33 However, there is a risk of a large administrative overhead if project management is devolved and it is likely that management functions relating to access and dissemination will need to be centralised. There was consensus that any change needs to be systemic and that all authorities need to sign up for everyone to benefit. If some authorities choose not to become involved it would mean having to implement password access and this was

seen as untenable as all visitors to the site should be able to access the same content.

4.34 The main management issues in the context of extending SOLSN relate to funding, content and training.

Funding

4.35 National funding will be needed for capital costs, such as servers able to deal with national demand, and recurring costs such as selecting content, overseeing compliance with NGfL content standards and digitising and updating materials. As administration of an online network requires specialist skills it is possible that high level technical decisions would be difficult if devolved.

4.36 It was also considered that SOLSN would need a national launch rather than a piecemeal effort and that every effort should be made to get all authorities signed up to it. It would not be possible for SOLSN to offer laptop computers or subsidised telephone bills as it had for the pilot phase and support from the authorities would be a prerequisite for success.

Content

4.37 Although there is an argument for some curriculum materials to have localised elements (in history and geography, for instance) there is not as strong a need in science. If generation and selection of content is localised there is the risk of duplication of effort and content.

4.38 This does not mean that content has to be produced centrally. A single administrative unit could put required content out to tender and it could be produced at geographically distributed locations. The finished products would be put in the public domain on a central server. The specification would ensure NGfL standards were met and commissioned materials would be a national resource.

4.39 SOLSN should be made available from a number of gateways as well as integrated with the NGfL. Links from the SOLSN site should be increased to add value and ensure it is a dynamic service.

Training and support for teachers

4.40 It was generally considered that training and support for teachers should be localised but this could be at different levels depending on its purpose. Help with day-to-day problems such as ICT troubleshooting requires a strong relationship between helpers and teachers; this is likely to be most effective if local and was seen as paramount in ensuring SOLSN's success. However,

simple curriculum enquiries could probably be met by having more extensive and catalogued FAQs available online.

4.41 Other training needs are broader and include information retrieval skills as well as the pedagogical dimension. Participants in the groups did not reach consensus on training. They voiced concerns that authorities would have different levels of commitment to SOLSN and that training could be overlooked if there were competing claims within an authority. Its importance for curriculum development would best be assured by funding training centrally: the training would be put out to tender nationally but delivered locally, as for the New Opportunities Fund training. Others suggested that authorities would be able to join SOLSN once they had demonstrated that they can meet various conditions, such as the provision of training and appropriate connectivity.

4.42 Other models included clusters of a secondary school and its feeder primary schools operating as a training unit. This has worked well in West Lothian but its effectiveness is variable, depending on the strength of the science department in specific secondary schools and their ICT resources. A range of models for training should be explored, including face-to-face and distance learning and mentoring. The New Opportunities Fund training offers the possibility of linking the use of SOLSN into its framework. As a NOF training provider, Fife has already started working on this.

Summary

4.43 Findings on which aspects of management should be centralised and which should be devolved are summarised in the following table. It should be noted that centralised does not necessarily imply a single location for services, as these could be devolved or networked, but a single entry point. Some aspects are described as both because it is thought that their management will evolve from centralised to devolved as SOLSN becomes more established.

Table 4.1: Summary of which aspects of managing SOLSN should be devolved or centralised

	CENTRALISED	DEVOLVED
funding	✓	✓
training	✓	✓
ICT support		✓
dissemination	✓	✓
submission of content	✓	✓
IPR	✓	
content administration	✓	

5: Pedagogical aspects

Introduction

5.1 This chapter encompasses SOLSN's impact on the organisation of teaching and learning science, whether the materials meet teachers' needs and the integration of SOLSN into lesson planning and programmes of study.

5.2 The pattern of usage changed as the trial progressed. As the teachers became more confident with the CD-ROM they used a greater number of areas on the site although the evaluation period was not sufficient for teachers to establish routine use. Newly qualified teachers seemed to get more use out of the CD-ROM. All the findings in this chapter are based on teachers' views as drawn both from interviews and the diaries.

5.3 Based on 35 entries in the diaries, most (24) sessions using SOLSN were between ten minutes and half an hour long, although nine sessions were more than half an hour long. As it can be difficult to make this amount of time available at school, this may explain why SOLSN was used at home on 14 occasions and at school on 18 occasions.

5.4 Based on both diary entries and interviews, there is a roughly even spread between teachers using their own computer, the SOLSN laptop or another school computer, with a slight bias towards using the laptop. This suggests the importance of laptops for using SOLSN at home. It is also an indication of the amount of time teachers would be online if SOLSN goes back to being entirely web-based.

5.5 It is outwith the remit of this evaluation to comment in detail on the Renfrewshire Science Pack. Nevertheless, it provides most of the existing content and is the section of the CD-ROM most frequently used by teachers. As the aims of the evaluation include assessing SOLSN's impact on teaching science and teachers' understanding of science it is necessary to consider the extent to which the materials derived from the Renfrewshire Science Pack provide the support to meet these aims.

Planning

5.6 The CD-ROM was found to be most useful for medium-term planning by slightly more than half (12) of the teachers and planning is considered by *Improving Science Education* to be a key to effective science lessons (SEED, 1999, 2.2 and 3.3).

5.7 In these medium term plans, which covered a few weeks or half of a term, the CD-ROM version of the Renfrewshire Science Pack was considered to

be a valuable means of relating lessons to the 5-14 documents, both as a source of new ideas and for confirmation of good practice.

5.8 The plans did not seem to have been used directly from the pack and so were not considered to save time. This was because most of the schools in the pilot study already had well organised science plans and so were only aiming to improve or update them.

5.9 The Renfrewshire Science Pack plans were not necessarily drawn up to the same format as the schools' plans and so had to be altered. Some schools had not used the plans because when they received the SOLSN CD-ROM the teachers had already submitted their own plans to the headteacher; other schools had completed their science topics earlier in the term. These schools intended to use SOLSN for planning in the next term.

Lesson preparation

5.10 The Renfrewshire Science Pack plans and worksheets were used mostly to add to existing banks of lessons rather than to generate lesson materials from scratch but they were found by many teachers to be helpful when deciding at which levels to pitch the activities. Diary entries showed that as the trial progressed substantially more of the Renfrewshire materials were being used in lesson preparation.

5.11 Some of the topics taught by the schools were not included in the Renfrewshire Science Pack or were not located where teachers expected to find them. One Primary 7 teacher expressed her disappointment that there was no material about pulleys and gears included in the pack, although she found a resource giving some details about pulleys in 'Shipwreck' in the Primary 3 section, along with a link to relevant material in the *Interactive Primary Newsletter*. She found this confusing because an understanding of simple gear and pulley systems is a requirement in the Forces and their Effects section (Primary 7 to Secondary 2) of the 5-14 Environmental Studies document (1993 version). The draft revised guidelines (SCCC, 1999) include pulleys at Level E, although gears have been removed. As level E is often taught in Primary 7 this would suggest that a section based on the Renfrewshire S1/S2 materials should be included.

5.12 Another teacher said that she could not find suitable material to help her to plan a science input for a topic on toys as studied in many Primary 1 classes. The section on 'pushes and pulls' comes in the pack at P3 level and the recording sheets and ideas were considered to be too difficult for P1. Based on 25 entries in the diaries, teachers were able to find some of the content they were looking for on 17 occasions. There is only one entry in which the teacher had been unable to find anything relevant to their search.

5.13 Locating material will be made more difficult by the revised guidelines because schools will now be starting to look at topics in 5-14 levels instead of Primary 1 to Primary 7 plans. Renfrewshire are revising their pack to take account of these changes but it also raises the issue of whose responsibility such updating is for the electronic version.

5.14 *Improving Science Education* discusses providing help for teachers with equipment requirements for practical work and suggestions for investigations. The SSERC Equipment List and supplier details that map onto the Science Pack are a good start at this type of help, but only five of the teachers in the trial accessed it on the disc. The SSERC components and materials list also contributes to the task of organising equipment but only four of the teachers interviewed had used it. Some of the teachers said that they intended to look more closely at these sections on the disc when they order equipment for next year as at the time they received the CD-ROM the schools had already ordered equipment for the current year.

Integration into lessons

5.15 The CD-ROM is used mainly to access the Renfrewshire Science Pack. At the time of the interviews only a few of the teachers in the trial had used a sequence of the worksheets to teach a series of lessons and they were mostly used as a source of good ideas for teacher-led activities.

5.16 This is partly because the worksheets were not generally perceived to be very attractive but it also highlights a tension between the emphasis on worksheets in the science pack and the advice in *Improving Science Education* (*Op. cit.*, 5.11) that teachers spend too much time managing worksheets and that time spent completing worksheets can be unproductive for pupils.

5.17 Those parts of the Renfrewshire Science Pack that were transferred to the CD-ROM do not provide enough in the way of alternatives to this approach to engage pupils in interacting with the subject matter, an area in which most teachers would value some guidance. There is no help, for instance, to indicate what kind of questions teachers should ask. *Taking a Closer Look at Science* (SCRE, 1995) states that 'it is important to ask oral questions which will encourage and enable pupils to express their ideas. Some kinds of questions are much better than others for this purpose' and describes how to ask questions. The exemplification of the 5-14 guidelines for science (SCCC, 1996) also gives examples of good practice that will promote pupil interaction by encouraging contributions from the children through investigations and discussion.

5.18 As the trial progressed diary entries reveal a greater usage of SOLSN in lessons. Several teachers listed some preferred websites as part of their diary entries. One teacher had given her pupils the opportunity to use the

CD-ROM in lessons and they had used the NASA link to find out about planets. She had also used the web to help with answering the children's questions. This school was networked when the disc was received and the teacher was a competent computer user with responsibility for software. The majority of the schools sampled had not used the CD-ROM in class, either for the children to access or as a resource for the teacher to answer their questions.

5.19 Teachers identified a need for help in the following areas:

- cross-curricular links
- investigations
- topics
- composite classes
- a primer which is accessible for children
- ICT support materials for the children to use with graphs and databases
- an improvement in the presentation of the teachers' support materials derived from the Renfrewshire Science Pack
- S1/S2 work up to level F
- differentiation and assessment materials.

5.20 *Improving Science Education* encourages the development of many of these aspects of science education and consideration should be given to commissioning materials or obtaining them from elsewhere to plug these gaps.

5.21 There should also be easily accessed guidelines on good practice and a bank of tips on how to introduce a lesson or organise questions and answers as these areas are missing from the present CD-ROM.

Assessment

5.22 Assessment materials are considered to be one of the most important items missing from SOLSN. The current lesson plans have a section called 'Possible Assessment' but they do not provide help with the production of diagnostic materials, nor do they give any help in selecting criteria against which the work can be marked. The level of guidance is inadequate.

5.23 For example, in Primary 6 Unit 4 Lesson 4 the suggested assessment is 'Work produced to be assessed'. In Primary 7 Unit 1 Lesson 3 the suggested assessment is 'Teacher to set targets' and in Primary 6 Unit 3 Lesson 2 it is 'Class/group discussion'.

5.24 This omission has been recognised by Renfrewshire who are currently working with Edinburgh to produce assessment materials. At the time of the original SOLSN trial Northern College did some work in this area.

5.25 As is made clear in *Taking a Closer Look at Science* (SCRE, 1995) learning science must involve pupils in exploring, investigating and communicating about things in the world about them. To help this learning, diagnostic assessment must take place in these same contexts. The strategies which teachers most often use to take a closer look at pupils' progress in science are observation, collecting products of learning, oral questioning and setting tasks. It is useful to have guidelines for focusing these assessments so that information is gathered which can be interpreted in terms of the skill strands. An explanation of these diagnostic procedures and examples of good practice should also be provided.

5.26 The consultation document on the revised Environmental Studies guidelines already mentioned (SCCC, 1999) also sets assessment in the context of effective learning and teaching. Section 5 states that it is important to share in advance a clear set of criteria, specific to the particular activity, against which the pupils' work can be judged. The teachers interviewed have requested assessment materials that provide guidance on placing pupils on 5-14 levels. They would also like a system of evaluating the success of lessons. Guidelines on assessment could be illustrated on the CD-ROM with a demonstration of how the evidence could also be used for reporting to parents and planning the next steps in learning.

Other resources for teaching science

5.27 At the time of the interviews three quarters of teachers still used other materials more than SOLSN. Other materials included *Ginn Star Science*, *Collins Science*, the *St Andrews College Space Pack*, the *Fife Guidelines* and packs of materials made up by the teachers themselves from a variety of sources. Several of these widely used 'third party' resources are referenced in the SOLSN CD-ROM.

5.28 The reasons given for a greater reliance on other resources were that science lessons had already been planned, the topics selected by the school were very prescriptive and did not match up with the Renfrewshire Science Pack and schools prefer to use schemes that have recently been bought.

5.29 The teachers in some of the schools visited did not think that science was part of their development plan, so they were not given time to further develop the science curriculum. Some of the schools said that they already had a core plan, so there was no need for other ideas. Other schools had put a lot of work into science project boxes in previous years and only used SOLSN to boost them.

5.30 The few teachers who used SOLSN more than other materials said that they preferred it because it was all 5-14 related and it was also more portable than books. Newly qualified teachers seemed to be more likely to use SOLSN. This may be because they had not accumulated other teaching

materials or they may have been more comfortable with the computer package than were older teachers.

Continuing professional development

5.31 One of SOLSN's main strengths is considered to be that it is an effective use of ICT. However, most teachers see it as a way of improving their own ICT skills rather than translating these newly acquired skills into ICT-based activities for pupils. As noted in 3.22, the decision to use web browser software for organising material on the CD-ROM has enabled teachers to learn how to use website resources without incurring any expense and without the risk of getting lost. Interviews reveal that the main use of SOLSN was for the preparation of lessons.

The role of ICT in learning and teaching

5.32 Computers were used by children in many of the classes taking part in the pilot, but only four teachers gave pupils access to the SOLSN disc. This could have been because of a lack of awareness of access to the live websites but also because the main use of computers in classrooms was for accessing topic-based CD-ROMS and word processing.

Sharing good practice

5.33 It had been hoped that schools would contribute their own resource materials so as to share their good practice. Some schools provided with scanners and digital cameras have contributed but this has been slow and many schools do not have plans to send in worksheets or lesson plans in the near future. Examples of the children's work and hints and tips from schools, advisers and cluster groups would help to build up a bank of good practice.

Impact on understanding of science

5.34 Slightly more than half (12) of the teachers interviewed claimed that the CD-ROM increased their confidence in teaching science and increased their understanding of the concepts.

5.35 They felt that SOLSN helps to give a clearer picture of the topics and the direction of the subject but several teachers commented that it is difficult to find all of the information about a topic. The arrangement of the Renfrewshire materials in Primary 1 to Primary 7 levels exacerbates this difficulty of access as the teaching materials are presented with all of the lessons for each primary stage presented together. As the 5-14 Guidelines are presented under the levels A to F this difference in presentation makes it an onerous task to audit the lessons against the requirements. The

Renfrewshire coordinators' materials that would help with this overview have not yet been included on the CD-ROM.

5.36 The revised guidelines for science give a better overview of the ideas to be developed throughout the years Primary 1 to Secondary 2 as a holistic account for each area. They also set out targets clearly for the development of ideas within the area across the levels A to F of 5-14.

Impact on methods of teaching science

5.37 A substantial number (14) of teachers did not find that their understanding of the methods of teaching science had changed as a result of SOLSN, although there was no consensus of opinion on what would have been useful in this context. The small number who said SOLSN had prompted an improvement in their teaching of science attributed it to the links related to progression in the Science Pack.

5.38 It was suggested at the focus group meeting that some of the material on the original set of CDis could be used as examples of good practice for introducing a topic, development of the children's ideas and organisation of investigations.

5.39 The *café* from the previous version was considered to have potential as a medium for teachers to discuss and reflect on how to teach science as well as to ask for help with practical aspects of the subject.

5.40 A range of teaching and learning activities is necessary if children are to acquire relevant scientific knowledge, skills and understanding. Teachers, especially those whose own background knowledge and experience of science is limited, need more support in the task of matching such a range of activities to the learning needs of children than is currently offered by SOLSN.

6: Conclusions and recommendations

Introduction

6.1 The levels of teachers' competence and confidence and classroom or school connectivity made progress of the SOLSN project slower than expected and plans to go online this year have been deferred. Similar problems beset Phase 1, although their impact at that time was considerably more severe.

6.2 Many schools have only recently been connected to the internet and the majority of teachers were not confident when using a browser. If the technology and connections to the internet were not fully operational then the SOLSN CD-ROM could not be fully explored and the links to websites were not known about in some cases. The provision of laptops went some way towards solving these problems although teachers still needed internet access at home or school and many teachers felt that they needed more time to familiarise themselves with the content and exploit its potential.

6.3 The CD-ROM itself was liked by the teachers. They found it attractive, understandable and navigable. Initial problems, such as unevenness in availability of discs, were dealt with quickly by the SOLSN team. The general opinion was that this version of SOLSN is much more teacher-friendly and less technology driven than the original SOLSN.

6.4 Using the CD-ROM and the web links had the additional benefit of contributing to teachers' continuing professional development in the use of ICT in teaching and learning.

6.5 This report has drawn on a range of perspectives to analyse the operational, managerial and pedagogical aspects of SOLSN and meet the aims of the evaluation. These are to:

- assess the extent to which SOLSN supports Scottish primary teachers to develop their understanding of science, improves standards in the teaching of science at 5-14 level and improves continuity between primary and secondary stages
- evaluate the viability of expanding SOLSN beyond the participants of the pilot study.

6.6 The conclusions in this chapter are based on these aims. Most of the conclusions relevant to the first aims are drawn from the pedagogical aspects discussed in Chapter 5. Most of the conclusions relevant to the last aim are drawn from the managerial aspects in Chapter 4 and the discussion of usability in Chapter 3.

The extent to which SOLSN supports primary teachers to develop their understanding of science

6.7 Slightly more than half of the teachers interviewed claimed that SOLSN increased their confidence in teaching science and increased their understanding of the concepts. On this measure, SOLSN has not met one of its main objectives. However, the interviews were conducted at a fairly early stage of the pilot study, in January 2000, and it has been noted (3.11 and 5.18) that responses from teachers became more favourable as time progressed and they had more opportunities to familiarise themselves with the content.

6.8 There are shortcomings in the arrangement of curricular information which inhibit development of a scientific overview. In particular, lesson plans are currently arranged by Primary 1 to Primary 7 levels whereas the 5-14 guidelines are presented under levels A to F. Making connections between lessons, whether part of the materials derived from the Renfrewshire Science Pack or based on other sources, could be made much easier by offering alternative ways of viewing the material and is likely to contribute to teachers' understanding of science.

6.9 For instance, having the ability to view all stages of developing a topic or area would help teachers to understand progression within it. There is a basic feature for seeing progression through the primary stages for each attainment outcome but a more sophisticated feature to allow scrolling through all the content relating to a specific area would make progression easier to track. This would also help fulfil the aim of improving continuity between primary and secondary schools and have an impact on methods of teaching science.

6.10 SOLSN has the potential to make continuing professional development more accessible to teachers but the content needs to be supplemented. There is currently little content that encourages reflection on individual knowledge and practice.

➤ Recommendations

6.11 The Renfrewshire materials should be restructured to provide different views of the content depending on the teacher's needs. This should include arranging the content by Primary 1-7 levels, by A-F levels and by curriculum area.

6.12 Teachers need personalised help in addition to the support provided by the SOLSN CD-ROM. Members of a support team should have a specific time allocation for SOLSN and the opportunity to offer face-to-face help,

although a *café* facility on an online SOLSN would probably meet some needs.

6.13 The materials currently available on SOLSN should be extended so that teachers have more opportunities to develop their own understanding.

The extent to which SOLSN improves standards in the teaching of science at 5-14

6.14 The finding that two-thirds of teachers interviewed did not consider that their understanding of the methods of teaching science had changed as a result of SOLSN is a cause for concern although the same proviso on the timing of interviews is relevant (6.7).

6.15 This is not a surprising finding as there is no clearly discernible material which has been written to develop teachers' pedagogical competences. The current emphasis of SOLSN is on the *content* of science lessons. This should clearly lead to improvements in the teaching of science but it also leads to a fragmented approach as the units are generally at the level of lessons and it is difficult to get a bigger picture. The close relationship between the subject content and the method of teaching is not explored by SOLSN.

6.16 The Renfrewshire Science Pack materials helped with planning, were a source of new ideas and provided confirmation of good practice. SOLSN was helpful when deciding at which level to pitch activities and provided advice on buying equipment (SSERC) and good ideas for activities (SSERC newsletters) although many teachers were unaware of content beyond the Renfrewshire Science Pack.

6.17 Planning and preparation activities frequently take place outside core time and at home so teachers appreciated the portability of the CD-ROM.

6.18 SOLSN could provide more support for teachers to encourage pupils to use relevant sections of the CD-ROM and to increase use of ICT by pupils in science lessons. This was not in the remit for the pilot project.

6.19 Findings from all of the sources emphasise the value of the strong links between SOLSN and the 5-14 curriculum but guidance on assessment is required.

➤ Recommendations

6.20 Materials which include advice about teaching and learning strategies should be identified and added to SOLSN. They could include materials which discuss different models of teaching and learning science and their various advantages and disadvantages, including explanations of a constructivist approach and how to implement it in classroom practice.

Transferring appropriate units of the CDi materials from Phase 1 could also be considered as part of this development.

6.21 Incorporate a feature in a new online SOLSN which is similar to the *café* in Phase 1 as a way of encouraging discussion and reflection on the teaching of science.

6.22 Encourage the use of ICT in science by providing a simple graphing package for use by pupils. Children could also be encouraged to use word processing to report their findings, databases to find patterns in their results and simple dataloggers with sensors to explore answers to their questions.

6.23 Planning and organisation could be improved by providing interactive planning sheets linked to each other and to cross-curricular topics, assessment and evaluation tools and the next stage of planning. The ability to customise electronically presented plans would give teachers and schools ownership of them.

6.24 Materials which provide support for assessment should be linked to the restructured content. These could include developmental criteria for teachers to use in observing their pupils in hands on activities and examples of questions to ask as a means of eliciting children's scientific concepts. SOLSN could help teachers to use the results of assessments to evaluate teaching and learning and plan accordingly.

The extent to which SOLSN improves continuity between primary and secondary stages

6.25 This aim is far from being realised and the SOLSN team recognise that there is an absence of materials which could improve continuity between primary and secondary stages. The first phase successfully used a primary/secondary cluster but this did not continue in Phase 2.

6.26 Secondary school teachers can use SOLSN to establish which topics should have been covered in primary science but there is not enough information to provide primary school teachers with requirements in Secondary 1 and Secondary 2.

6.27 Providing content relevant to Secondary 1 and Secondary 2 will increase the numbers of teachers involved and there will be additional training requirements.

➤ Recommendations

6.28 Content relevant to the primary/secondary transition should be identified or produced. In particular, material suitable for level F of 5-14 should be provided. Assessment materials provided and structured as recommended

above would greatly improve liaison and continuity across primary and secondary schools as well as across levels.

The viability of expanding SOLSN beyond the participants of the pilot study

6.29 The main issues relating to extending SOLSN are outlined in Chapter 4. They include training and support, the management of intellectual property rights, deciding whether to go online, funding and content.

6.30 The conclusions of the focus groups were to maintain the current hybrid model of a CD-ROM with both cached web resources and external links for now but work towards going online in two years' time. The rationale for this is that the government has set a series of targets for the year 2002 which encompass training with ICT and an appropriate infrastructure. If met, the targets will ensure there is sufficient confidence, competence and connectivity for an online SOLSN to be assured of success.

6.31 In the meantime, the CD-ROM will need updating to take account of revisions to 5-14 guidelines, changes to linked websites and the sourcing and addition of new content. As the CD-ROM uses web browser software it should be a fairly simple task to transfer the content to a SOLSN website in the future and the intervening period can be used for further piloting.

6.32 There was strong support for a funding commitment which extends over three years as this would carry the project forward through its continuing interim phase but allow for preparation for going fully online in 2002.

6.33 The funding should encompass some elements of the costs of training, specialist technical input on preparing for integration with the NGfL and a content specialist for keeping materials up to date and commissioning new content.

6.34 Funding should be centralised but the development of content would be put out to tender nationally and produced locally. A range of models for training should be explored to establish their costs and benefits.

6.35 It will be particularly important to address usability issues before SOLSN rolls out. Teachers were forgiving of some of the problems they encountered and, in part, this is probably because they were aware this has been a pilot study. Making SOLSN available on a nationwide basis will lead to teachers having higher expectations, especially as most teachers will have completed some ICT training by the suggested target launch date of 2002. Poor usability will lead to low take-up in a further phase and this will have a detrimental effect on the first three aims of SOLSN.

6.36 As teachers will increasingly use ICT for teaching and learning they would benefit from becoming more aware of interface design. If these materials

had retained their current design but been paper-based teachers may well have been more vocal in their criticisms. Once teachers have had more experience of accessing websites they will feel more confident to make judgements about what meets their needs and this will be of benefit to designers.

6.37 The main usability problems relate to structure, navigability and lack of consistency in the use of colour and terminology. Many teachers were unaware of some key features of the SOLSN site.

➤ Recommendations: the management of extending SOLSN

6.38 The current hybrid model should be retained and supported for now by updating content and continuing to offer help to users of the CD-ROM.

6.39 Development work for going online in 2002 should be conducted in parallel. This includes addressing new training needs, IPR and funding.

6.40 Consideration should be given to a three-year funding commitment to provide continuing support for the present implementation of SOLSN and its transition to being online. Funding would need to be sufficient to develop the technological, design and content elements of SOLSN as well as making a contribution towards the costs of providing training.

➤ Recommendations: usability

6.41 The SOLSN team needs to conduct or commission formal usability testing. This should take the form of observing a range of teachers using the CD-ROM for authentic tasks and capturing data through 'think aloud' protocols or stimulated recall.

6.42 The design needs a clean, professional look. The SOLSN team should redesign the interface, based on findings of the usability testing, enlisting assistance from a professional interface designer for this purpose. This should be followed by further usability testing.

6.43 The scope of the current tutorial should be extended to include the use of search engines and other topics suggested by teachers. A paper-based manual should also be provided. Project management schedules should build in more time for editorial work so as to ensure that all text can be proof-read for accuracy and clarity of meaning and intent.

Final conclusions

6.44 Although the findings of this evaluation study have not been entirely positive, there is enough evidence to believe that SOLSN should be further developed. Most teachers welcomed SOLSN and believe that they will use it more in the future. The evaluation was probably conducted too early in

Phase 2 to get a fully representative picture of use. Its timing in the school year with reference to planning and equipment purchases and some delays in schools becoming fully connected to the internet meant that teachers did not have the opportunities to familiarise themselves with SOLSN.

6.45 A consideration of value for money was outwith the terms of this evaluation but SOLSN appears to have been produced on a low budget and a short timescale. SOLSN should aim to provide a really good example of support for 5-14 science. If a quality product suitable as a national resource is to be developed more funding will need to be committed to producing or buying quality materials, particularly in the areas of assessment, pedagogy and primary/secondary transition. This should still be a relatively inexpensive way to provide good quality continuing professional development and support for science teaching. The cheapest paper-based published scheme would cost about £1200 per school. If SOLSN were to be developed along the lines suggested in this report it would be both more cost effective and a much more extensive and all inclusive resource with a number of benefits not available with paper materials.

6.46 The recent publication of *Improving Science Education 5-14* provides an ideal impetus for national developments in supporting science and providing continuing professional development opportunities in both science and ICT. SOLSN could make a major contribution to the aims of improving science education.

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Appendix 1: Participating education authorities, schools and teachers

Education Authority	School	Headteacher	Teachers
Edinburgh	Queensferry	Sheilah Jackson	Christine Sawers Morag King Karen Deveney
	Wardie	Susan Gow	Karen Gardener Doreen Hunter Linn Kent Janet McLoughlin
	Royal High	Ms Brear	Adriaan Ruis Janet Wallace Joan Sinclair
Fife	Newcastle	Liz Johnson	Ruth Wishart Alastair Hughes Fiona Cameron
	Pitreavie	Clare MacNeill	Jenny Dale Margaret Gibson Kathryn McSkimming
West Lothian	Linlithgow	David Simpson	Janette Kean Moira Keevins
	Lowport	Lesley Cameron	Sue Woods Elizabeth Wood
	Springfield	Joan Beattie (AHT)	
	Winchburgh	Margaret Balfour	Alison Watt
	Bridgend	Jane Will	Helen Rarrity Tracy Nelson Mrs McRae

Appendix 2: Participants in telephone interviews and focus groups

Telephone interviews

Peter Anderson	Chair SOLSN steering group and Adviser, ASDARC, Fife
Jim Birney	IT Section, ASDARC, Fife
Ian Birrell*	SSERC
Ian Buchanan*	SSERC
Alan Dawson	Content Specialist, National Grid for Learning
John Dickie	Staff Development Specialist, National Grid for Learning
Marie Dougan	Education Support Services, Edinburgh
Bill Fleming	Educational Development Officer, Renfrewshire
Bob Kibble*	Chair SOLSN Curriculum Group and University of Edinburgh
Meg Lamb	Curriculum Support, West Lothian
Carol McDonald	Member SOLSN curriculum group and Linlithgow Academy, West Lothian
Nick Morgan	Manager, Scottish Virtual Teacher Centre
Jim Murdoch	Northern College of Education
John Richardson*	Executive Director, SSERC
Brian Scott	IT Section, ASDARC, Fife
Walter Whitelaw	Adviser for Science and Technology, Edinburgh

* Interviews conducted in person

Focus Groups

Peter Anderson	(Chair)
Jim Birney	IT Section ASDARC, Fife
John Dickie	Staff Development Specialist, National Grid for Learning
Karen Deveney	Queensferry Primary School
Bill Fleming	Educational Development Officer, Renfrewshire
Janette Kean	Linlithgow Primary School
Jim Murdoch	Northern College
Adriaan Ruis	Royal High Primary School
John Richardson	Executive Director, SSERC
Brian Scott	IT Section, ASDARC, Fife

Appendix 3: SOLSN evaluation advisory group

Beverley Allan, Pitreavie Primary School, Fife

HMI Dr Jack Jackson

John Richardson, Scottish Schools Equipment Research Centre

HMI Stuart Robertson

Evaluation team

Professor Wynne Harlen

Alison Leakey

Dr Lydia Plowman

Appendix 4: Design of the study and timetable

Stage	Activities	Timescale
1	**Preliminary Stage** • Inception meetings with SOLSN team and teachers • Design of instruments • Contact with all teachers	November & December 1999
2	**Data collection** • Diaries and information leaflets to all teachers • Visit all schools for interviews • Visits/telephone interviews to helpers, other stakeholders and SOLSN team	January & February 2000
3	**Further data collection, analysis and reporting** • Initial analysis of data • Focus groups • Integrate findings from focus groups • Submit final report	March & April 2000 end April 2000

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